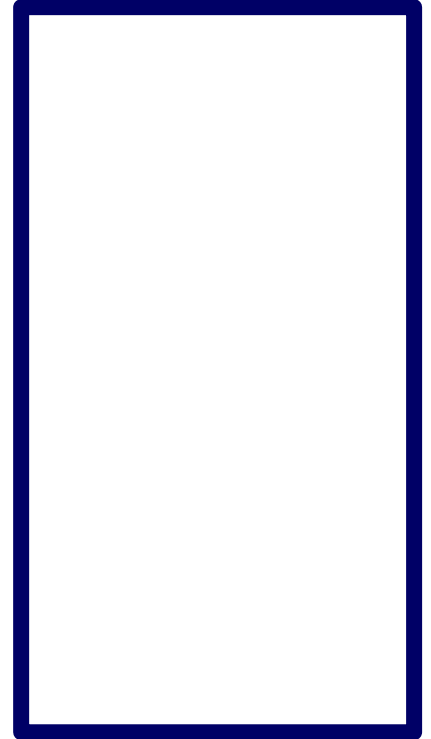


Safety Training and Design, Permitting, and Operational Guidance for Gaseous Fuel Vehicle Facilities



Principle Investigator: Rob Adams

Presenter: Rob Adams, P.Eng, CPA, PMP

Organization: Marathon Technical Services USA

Date: June 19, 2018

Project ID # ti080

Timeline

- Project start: 2016 10 01
- Project end: 2019 09 30
- Percent complete (dollar based as of Mar 2018): 37 percent

Budget

- Total project funding: \$940,912.
 - DOE share: \$750,000
 - Contractor share: \$190,912.
- Federal Funding received in FY 2017: \$232,980.16.
- Federal Funding for FY 2018 (to March 2018): \$18,361.15

Barriers

- Garage upgrades are a cost barrier—in extreme cases exceeding station costs
- Current codes poorly understood and applied
- Owners can gold plate or under design in response-affects project viability and safety

Partners

- Prime: Marathon Technical Services USA Inc.
- Sub: Clean Fuels Ohio
- Sub Subs: 7 Clean Cities Coalitions

Why is this Assistance Needed?

This project provides a comprehensive summary and knowledge transfer of codes and industry best practice for the upgrade of garages serving:

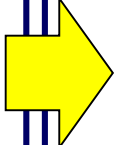
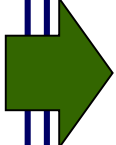
- CNG Compressed Natural Gas) Vehicles
- LNG (Liquified Natural Gas) Vehicles
- LPG (“Propane”) Vehicles
- H2 (Gaseous Hydrogen) Vehicles

In addition to the barriers in the Overview slide:

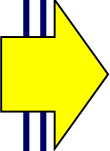
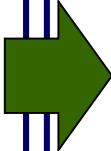
- It is desirable to provide training at no cost—this precludes private training providers from offering this service without outside assistance
- Industry training currently has focused on vehicle and fueling technologies and not on the garage, even though this can be the most costly barrier to a gaseous fuel project
- Design work is often undertaken by local A&E firms—these firms may lack sufficient experience to provide a best practice design.
- The small number of fueling station manufacturers have a concentration of expertise, but garage upgrade knowledge is less concentrated.



Project Objectives

Objective	VTO Goals	Impact
<ul style="list-style-type: none">▪ Increase industry awareness of current codes▪ Increase industry skill in adapting current codes to actual field conditions▪ Document code and best practice requirements in a well illustrated training manual▪ Provide training sessions in various US cities	 <ul style="list-style-type: none">▪ National Security-safe and cost effective garages encourage transition to domestic gaseous fuels▪ Economic Growth-reduced cost will improve monetary viability of projects=more projects▪ Affordability▪ Reliability	 <ul style="list-style-type: none">▪ Better industry understanding will empower designers to provide safe and cost effective upgrades▪ Code officials will understand the application of codes leading to more effective administration of code requirements

Project Objectives

Objective	VTO Goals	Impact
<ul style="list-style-type: none">▪ Identify and showcase “Best Practice” facilities—providing exemplars that can be adapted to new projects.▪ Best practice facilities are across a variety of building and fleet types and climates.▪ Document the best practice facilities and make these available nationally	 <ul style="list-style-type: none">▪ National Security▪ Economic Growth▪ Affordability-reduce cost through rigorous but not excessive upgrades▪ Reliability-ensure that garages operate safely avoiding incidents	 <ul style="list-style-type: none">▪ Not “reinventing the wheel”-leverage design approaches already in use▪ Build/improve on past projects to provide greater safety at reduced cost▪ Provide code officials and owners with confidence that proposed designs are proven safe



Project Approach & Milestones

Year 1 Milestones

- 2016/2017
- Identification of potential garages to visit
- Coordinate, visit and document best practice upgraded maintenance garages.
- Code and literature review of garage upgrades
- Develop training manuals
- Compile Best Practice Case Studies

GO/NO GO

Year 2 Milestones

- 2017/2018
- Complete development of training manuals and PPT
- Peer review of training materials
- Coordinate training sessions
- Execute initial on site training sessions (Jun to Sep 2018)
- Receive training feedback

GO/NO GO

Year 3 Milestones

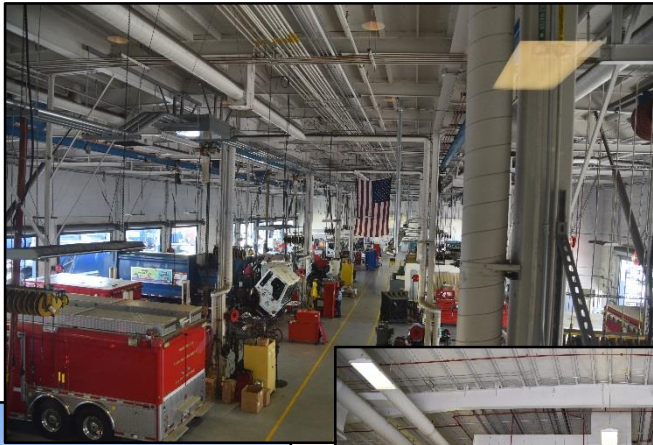
- 2018/2019
- Complete on site training sessions (Oct to Dec 2018)
- Receive training feedback
- Adapt training materials for on-line training
- Set up on line resource center
- Provide webinar training for each fuel
- Project closeout



Project Accomplishments & Progress


Identification and Evaluation of Gaseous Fuel Garages

- Located and evaluated garages for all gaseous fuels (CNG, LNG, LPG and H2)
- Documented the building design and operational characteristics
- Developed 18 Case studies for a representative sample of garages



Case 1

Niagara Frontier Transportation Authority, Buffalo NY



Vehicle Types


- 40' Transit Buses
- Cutaway Vans

Fuel Types in Garage

- CNG
- Diesel
- Gasoline

Upgrade 2015 - 2016

- Total Cost \$2.2M
- Cost/FT² ~ \$18 (average)
- Estimated \$80 to \$100/FT² in maintenance shop

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Photos provided by Marathon

Project Accomplishments & Progress

Development of User Friendly Training Manuals

- One training manual for each of CNG, LNG, LPG and H2
- Manuals provide a basic understanding of the fuels, then address each building upgrade purpose, requirement and recommendation from a code and application perspective.
- Picture and diagram rich format to enhance understanding
- Compilation of Best Operating Practices from Fleet Operators

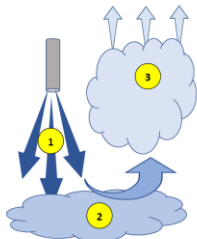
CNG Leaks and Release

Leak Behavior:

Although natural gas is lighter than air, there are conditions under which it will not always rise immediately.

Fast Leak-Vertically Downward (or Horizontally)—Phase 1:

Under a fast leak scenario, such as a serious fitting leak or component failure that is audible, the gas will have significant jet force and will release in whatever direction it is pointed. In a vertically downward leak scenario, the gas plume (jet and cloud) will first vent downward **1**. This scenario is also true for a horizontal release—the gas will first travel in the direction the jet is pointed.



Fast Leak-Vertically Downward (or Horizontally)—Phase 2 and 3:

Gas leaking from a CNG is expanding from a highly pressurized state to atmospheric pressure. This expansion causes a significant effect referred to as "Joule Cooling". The cold gas cools the air until the gas warms up to near atmospheric air temperature.

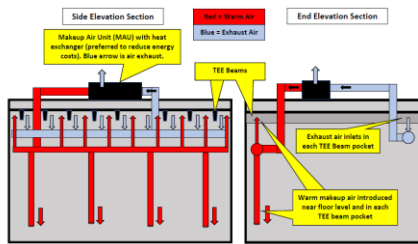
As it warms, it will rise as a plume or cloud toward the ceiling **2**.

For this reason, CNG garages include warm air introduction near the floor with exhaust at the high point. This quickly dilutes and pushes a gas plume to the detection and exhaust systems.

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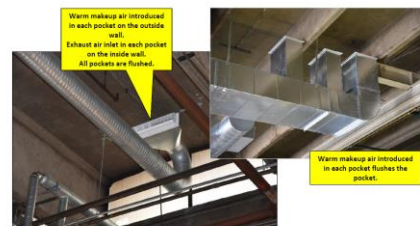
Ventilation Amount and Location

Best Practice Baseline (Continuous) Ventilation for Flat Roof with Precast TEE Beams



Ventilation Amount and Location

Best Practice Baseline (Continuous) Ventilation for Flat Roof with Precast TEE Beams—Typical Installations



Best Practice/Advice from Fleet Owners

In the process of compiling this manual, the fleet owners interviewed were very forthcoming with advice for others. In some cases, it was requested that this be kept confidential and therefore, a composite list was assembled and is presented below. Items are not listed in order of importance. In some cases, there may be some differing opinions—both have been provided.

CNG Best Practices/Lessons Learned:

1. Be committed to your fuel of choice—don't "dabble" in alternate fuels.
2. If you are designing a new facility (even if you don't have CNG vehicles) design it to be CNG "friendly" (easily ventilated roof, HVAC system that will not need to be replaced or heavily renovated).
3. If you are designing or upgrading your facility, tour other CNG facilities and learn from their experience. Don't reinvent the wheel.
4. Buy gas directly and if possible using a state or other buying cooperative.
5. Our agency limits defueling—only when required, due to our concerns about possible cylinder damage.
6. Depending on gas detection system technology, plan for quarterly, semi-annual or annual gas detection system calibrations and functional tests using gas to trigger the building response systems.

Action Item/Calibration points accessible at floor level, gas detectors available to maintenance staff and use them if a leak at regular PM intervals (see picture to the right). Interview staff as CNG cylinder/vehicle inspectors. Recommend field inspectors on staff.

If vehicle technicians before the vehicles arrive, bring some area(s) of the shop as minor repair to reduce upgrade cost.

by "classifying your garage as "minor repair"—it is too limiting. Instead, upgrade for "major repair", right buy upgrade to save cost". In some cases, it is lower cost to upgrade the entire shop and it provides much flexibility.



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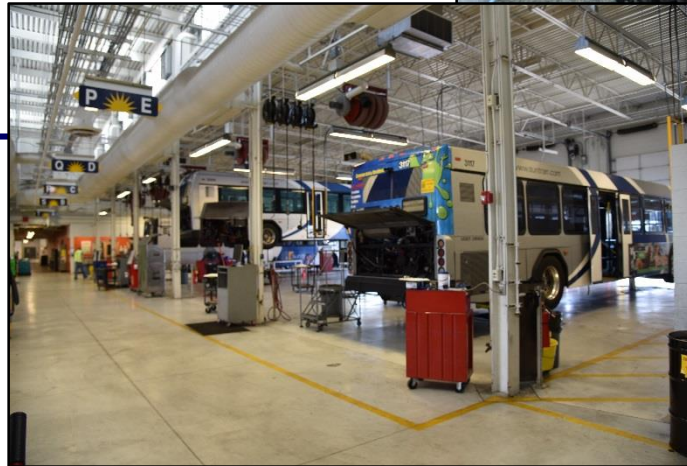


marathon

Project Accomplishments & Progress

Gaseous Fuel Training Sessions

- Identified 9 cities for training across the US in a wide variety of climates
- Established agreements with facility owners to permit the use of 21 host fleet facilities for tours during on site training.
- Buffalo NY
- Canton OH
- Columbus OH
- Kansas City MO
- Long Beach CA
- Richmond VA
- Sacramento CA
- Seattle/Tacoma WA
- Tucson AZ



Photos provided by Marathon

Collaboration and Coordination Among Project Team

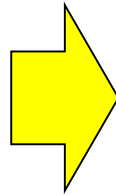
Prime Contractor

Subcontractor

CC Coalition Partners



(All logos used with permission of partnering organizations)



Marathon and Clean Fuels Ohio (CFO) Provide:

- Overall project planning and tracking
- Coordinated messaging to team and public
- Regular scheduled and on-line communication with Clean Cities Coalition Partners (CCPs) (Sub Subs)
- CFO manages communication with CCPs
- CCPs manage communications with Fleets



Collaboration and Coordination Among Project Team

Hosting Fleets

Local Clean Cities Coalition Partner is the primary line of communication. List of Hosting Fleets:

- Amphi School District, Tucson AZ
- Chesterfield County VA
- City of Columbus OH
- City of Dublin OH
- City of Edmond WA
- Pierce Transit, Tacoma WA
- City of Long Beach CA
- Franklin County OH
- Niagara Frontier Transit Authority, Buffalo NY
- KC Transit, KC MO
- North Kansas Schools, North Kansas MO
- Long Beach Transit, Long Beach CA
- Greater Richmond Transit Company, Richmond VA
- Suntran, Tucson AZ
- City of Sacramento CA
- County of Sacramento CA
- Sacramento Regional Transit Authority
- Stark Area Transit Authority, Canton OH
- Try-It Distributing, Buffalo NY
- City of Tucson AZ
- Wyandotte County KCKS

Collaboration and Coordination Among Project Team

Communications

Within Team:

- Google Drive with “live” project schedule, deliverables and resources available to entire team and to DOE
- Regular conference calls scheduled around the release of new information from PM (Project Management-Marathon and Clean Fuels OH)
- Supplemental calls as required to address issues
- Regular emails to update team members on project status and needs
- Follow-up emails as deliverables deadlines approach
- PM setup templates for training information and an Eventbrite invitation template for use by Clean Cities Coalition Partners

External:

- Website www.safegasgarage.com and www.safegasgarage.org to provide the public with information on scheduling and registration for training sessions and with other resources
- Clean Cities Coalition Partner websites to promote local trainings

Immediate Impact:

- Document: Single source manual with clear, coherent and comprehensive guidance on required/recommended garage upgrades:
 - One manual for each of CNG, LNG, LPG and H2
 - Addresses different building types and features
 - Addresses different climatic conditions
 - Cost experience
 - Industry best practices for operations from a variety of fleets
- Document: Case Studies for Best Practice Garage Upgrades—to provide further guidance and validation of recommended upgrades:
 - Variety of fleet types represented
 - Addresses different building types and features
 - Addresses different climatic conditions
- Training: On-site training is nationally disseminating the materials and knowledge to Fleet Owners, Consultants and Code Officials.
 - This information will be further disseminated through the networks of class attendees.

Potential for Legacy Impact Beyond Initial Project Period:

- Year 3 is the culmination of the preparatory phase of this project with the completion of on-site training and the establishment of ongoing training and industry resources.
- Year 3 work will provide an ongoing training and education tool using the Website www.safegasgarage.com and www.safegasgarage.org to provide an ongoing training and resource platform
- Other industry websites including Marathon, CFO and DOE will also provide ongoing access to these resources
- Future on-site training will also be provided beyond this contract period

Needs/Goals:

- Meets all four VTO goals (national security, economic growth, affordability, reliability)
- Fills a gap in the industry costing millions of dollars per year and causing safety concerns
- Easy to use/no cost resource to reduce costs and increase safety combined with line training and followed by on-line training

Collaborations:

- Working with 8 Clean Cities Coalitions nationally
- Working with 21 fleet owners nationally in a variety of fleet types
- Target audience: fleet owners, design consultants, code officials
- Information will continue to flow through these channels after project completion.



Accomplishments:

- Development of a single training manual for each fuel that brings together the required basic and detailed understanding of garage upgrade design in a clear and coherent way.
- Development of a no cost, high quality, compressed in class/in field training program
- Securing fleet operators willing to host tours of garages for the betterment of other fleets.
- Locating and documenting best practice upgraded facilities in the form of case studies as a means to push this knowledge to a national audience.

Potential for Legacy Impact Beyond Initial Project Period :

- Long term availability of this information and knowledge through an on-line presence using websites developed under this project and other industry resource websites.
- Future on site training